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HELIOPHYSICS SUBCOMMITTEE

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MEETING MINUTES

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Maura Hagan, Chair

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Jeffrey Newmark, Executive Secretary

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Wednesday, October 10, 2012

Welcome, Overview of Agenda

Dr. Maura Hagan, Heliophysics Subcommittee (HPS) Chair, opened by reviewing the agenda. This meeting was planned to allow ample time for deliberation on any findings the Subcommittee wanted to send to the NASA Advisory Council (NAC).

Heliophysics Division Overview

Dr. Barbara Giles, Director of the NASA Heliophysics Division (HPD), provided an update on Division activities. The Division's most exciting recent accomplishment was the launch of the Radiation Belt Storm Probes (RBSPs). While the probes were still in the commissioning phase, most of the instruments were already taking in data. This process was going smoothly, and the data looked extremely clean. HPD was planning a press event about the probes and the initial results.

August was also extremely busy due to the release of the Decadal Survey (DS). HPD was busy preparing a response to the DS and hoped to have a town hall addressing the report. The Magnetospheric MultiScale (MMS) mission Key Decision Point-D (KDP-D) Systems Integration Review (SIR) also occurred in August. This project phase ensures that MMS objectives, commitments, and milestones are being met. MMS remained within its cost commitment despite tight resources. The Standing Review Board (SRB) and Directorate Program Management Council recommended that the Agency Program Management Council approve the project to proceed; action was pending. With 2 years to go, resources remain tight, which was of some concern. Dr. Giles added that funds that had been previously allocated to the Astrophysics Division (APD) Gravity and Extreme Magnetism (GEMS) mission, which was cancelled, stayed with NASA's Science Mission Directorate (SMD). Because those funds had to be reallocated quickly within SMD, and because HPD was able to commit the funds to MMS right away, the rephrasing occurred to the benefit of both Divisions. HPD will return the funds to APD in Fiscal Year 2014 (FY14).

HPD has four programs: Solar Terrestrial Probes (STP), Living with a Star (LWS), Explorers, and the Research Program. With the STP Program's MMS mission set to launch in 2015, the DS made a recommendation for the next large STP mission. The RBSP and other LWS missions are all doing well. Within the Explorers Program, the Interface Region Imaging Spectrograph (IRIS) is scheduled to launch in June 2013. Dr. Giles reviewed key milestones for FY13 and FY14, noting that there was no funding for additional solicitations beyond the usual Research Opportunities in Space and Earth Science (ROSES), and she does not anticipate a new Explorer solicitation until FY15.

There were currently three Explorer full missions under study, as well as three Explorer Missions of Opportunity (MoOs). The plan was to select one of each, depending on the budget. The full missions had completed their Phase A studies, and review was ongoing. This was the second step of a two-phase procurement process. Dr. Giles asked the Subcommittee members to get word out to the community about the importance of respecting proprietary information and the review process. Rumors occur, and they should be communicated to Dr. Newmark so that he can address them. The goal is to be fair to all parties.

Dr. Giles next reviewed SMD's complete list of missions and spacecraft. HPD had five missions in formulation and development, which was a good representation considering that the Division had the

smallest budget within the Directorate. With recent issuance of the DS and the upcoming roadmap, HPD had an opportunity to provide momentum to the Heliophysics community. The Division was doing well, although it was important to manage resources carefully and ensure that the missions in development stay within their cost commitments.

The DS provides an occasion to think about the HPD science objectives. A Roadmap team will develop HPD's official response to the DS in context of the three HPD objectives that NASA has stated in its recent budget documents:

- Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium;
- Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres; and
- Maximize the safety and productivity of human and robotic explorers by developing the capacity to predict the extreme and dynamic conditions in space.

HPD will report its performance against those objectives. Dr. Giles hopes to have these objectives in the next SMD science plan and the next NASA strategic plan. The Roadmap activity will help determine whether and how to change the objectives, and how to map progress to them. Dr. Giles added that people sometimes do not readily understand the differences between the STP and LWS programs. These programs must be distinct, and HPD will review their focus.

In early October, Dr. Giles and other SMD representatives visited the European Space Astronomy Centre (ESAC) in Spain, in order to discuss a bilateral agreement with the European Space Agency (ESA). The meeting went extremely well. ESA plans to issue new solicitations for medium- and large-class missions. Dr. Giles would like to see the U.S. heliophysics community interact with ESA more, especially now that the DS has been released. While the HPD budget cannot accommodate anything outside the DS, it would be useful to explore opportunities for partnership.

In November, in Irvine, California, the National Research Council (NRC) will conduct a workshop called "Survey of Decadal Surveys." The purpose is to identify lessons learned and determine what did and did not work, though there will be no findings or recommendations. This is an open meeting in which several panels will provide discussion points, then open up the floor for dialogue. The panels have been selected, but anyone in the community can attend. It is also possible for people to send their thoughts to the individuals who will be on the panels, then interact during discussion time. There will be a minimum of 1 hour per panel to provide input. The Standing Committee on Solar and Space Physics (CSSP) stood down while the DS was being developed, and is now standing back up. There may still be opportunities to give input to NRC on CSSP membership.

While HPD is operating under a Continuing Resolution (CR) for FY13, the assumption is that the final budget will provide $178.9 million for heliophysics research. Planned accomplishments for the fiscal year include the IRIS launch and the first Balloon Array for RBSP Relativistic Electron Losses (BARREL) campaign. MMS will complete its SIR and start integration and testing, while the Solar Orbiter and the

Solar Probe Plus (SPP) will move from formulation into development. Finally, HPD will select the next Heliophysics Explorer.

Flight Program Status

Dr. Vicki Elsbernd presented an update on HPD missions, noting that most will meet their external commitment dates earlier than scheduled. RBSP had been engaged in commissioning activities since its launch on August 30; commissioning was expected to be completed by late October.

Even though some instruments had yet to come online, RBSP had already picked up some of the chirping and whistling radio waves emitted by Earth's magnetosphere. The Relativistic Electron Proton Telescope (REPT) was moved forward in commissioning in order to have overlap with the Solar Anomalous and Magnetospheric Explorer (SAMPEX). RBSP had come in under budget, and was the first SMD mission with a baseline under a new earned budget management initiative that NASA has implemented for cost containment. Both SPP and the BARREL balloon mission were going well; the latter was preparing to measure Van Allen Belt activity.

In the STP program, $33 million in Unfunded Future Expenses (UFE) were soon to be approved so that the probes can move into Phase D later in October. MMS is still within its cost and schedule commitments. Some margins are tight, but it looks good with 2 years remaining. The next key milestone is Instrument Suite 1 delivery to Observatory 1. No significant technical issues have been identified with the MMS. The Comprehensive Performance Test (CPT) for Instrument Suite 1 was successful, but the team was examining a power control box issue. At the same time, everything was complete on Spacecraft Bus 1, and Instrument Deck 1 integration was on time. There were continuing problems with the Explorer program communications system, and the team was looking at the likely fixes and schedule adjustments. The S-Band anomaly had moved the schedule back. This is a known feature and the corrections were proceeding.

Operating missions were going extremely well. There were two sounding rocket launches in the previous month or so. The RockSat-X provides a good training opportunity for student flight programs. The Talos Terrier-Oriole configuration is so long and thin that it looks unlikely to succeed, but it actually works as a back-up option and performed very nicely.

Measurement Techniques Workshop

Dr. James Spann, from NASA Marshall Space Flight Center (MSFC), explained that the Measurement Techniques Workshop is a conference set for August 2013 at the National Center for Atmospheric Research (NCAR). The Workshop will gather the world's experts on advanced measurement for solar and space physics, with the goal of articulating both the state of the art and future directions. The Workshop will identify cutting-edge techniques, which are addressed in the DS, and will allow students and non-experts to become familiar with measurement techniques. One of the results will be a four-volume series to document the current state and future directions of measurement techniques and instrument technologies, also serving as a reference for students and scientists to better understand solar and space physics measurements and how such measurements contribute to understanding of the science.

The Workshop will further provide the community with an opportunity to address technologies identified in the DS, which stated that the most significant advances will come from new observation technologies, innovative approaches to data, and more capable observational platforms. The four focus areas – fields; particles; photons; and ground-based – are not all-inclusive, but provide an organizational structure for the Workshop. Dr. Spann envisions the papers as capturing both technologies and techniques, including software and means of dealing with large volumes of data. The organization of the Workshop closely aligns to the instrument technology focus areas in the DS. In assessing current state-of-the-art techniques and technologies, the Workshop will help identify issues that prevent further progress.

Discussion
When asked if the speakers and discussion would provide the basis for the chapters, Dr. Spann explained that this involves a lot of work, and it could be that others do some of it. He expects the book to reflect the Workshop, with plenary sessions providing the headings and the breakout sessions being the basis for papers that form the volumes. The organizers are already working with some publishing companies, and plan to make the book available to everyone electronically, potentially as e-books.

Regarding proprietary information, that will be self-regulating, as presenters will not share what they prefer to keep close, though some are more open than others. In answer to a question about the mix of reviews or tutorials with information about state-of-the-art technologies, Dr. Spann said that the quest for balance drove the Workshop's organizational structure. Dr. Giles suggested that the experience of those who organized a previous conference could be helpful, possibly as consultants. Dr. Spann replied that those individuals, as well as the editors of the previous volumes, were contacted but are unable to participate this time.

Radio imaging will go under the "fields" focus area, although it might have gone under "photons." There were conversations about organizing in various ways before the four focus areas were selected. Workshop organizers plan to pull in National Science Foundation (NSF) expertise on the role of ground-based technologies. Ultimately, those who run the sessions will provide the content.

R&A Status
Dr. Arik Posner, the HPD Research and Analysis (R&A) Lead, explained that the R&A Program incorporates mission operations and data analysis; the majority of HPD R&A programs; the Community Coordinated Modeling Center and the Heliophysics Science Support Office; Data Centers and Data and Environment programs; and the Sounding Rockets and the Rocket Range infrastructure at the Wallops Flight Facility (Wallops). The Wallops infrastructure is managed on behalf of SMD as a whole and accounts for a significant portion of the annual R&A budget of $160-180 million. The public perception is that HPD has the largest R&A budget within SMD, when in fact it is the smallest competed budget due to the support for Wallops. Dr. Hagan asked whether it might be possible to break out the Wallops support from the overall R&A program. Dr. Giles replied that the conversation has taken place, although there are many implications in doing so.

The very high numbers of competed R&A proposals lower the success rate of funding proposals. HPD has begun implementing a two-step submission process, and has combined submission dates for Supporting Research and Technology (SR&T) and the Heliophysics Guest Investigator Program (HGIP).

This reduces review time somewhat and has not been shown to create a significant hardship for the proposers. There is also increased emphasis on performance reporting. Newly awarded Principal Investigators (PIs) will be asked to report all accepted, peer-reviewed publications to HPD.

HPS had previously asked HPD to provide information connecting the DS workforce analysis data with the success rate of competed R&A. As part of the response to this request, Dr. Posner presented various graphs showing SMD ROSES selection rates by division. The numbers of proposals are affected by the areas that are open for competition. The volume and rate are also affected by funding levels and by the funding and competition cycles. The DS recommended augmenting the HPD R&A program, and also called for Heliophysics Science Centers that would enable larger grants of longer duration. These centers would require an augmented budget.

Although the number of U.S. and Canadian PhDs in relevant fields is growing each year, the constant funding level means that there are fewer new positions available. This is having impact on proposals, as more potential investigators are submitting more proposals more frequently. After Dr. Robert McPherron made note of the significant discrepancies among journals in providing credit to researchers, Dr. Posner advised that investigators inform HPD of their activities directly. Dr. Giles added that the official record is the progress report submitted at the end of the year.

Dr. Max Bernstein of NASA noted that as R&A programs transition to longer awards, there are more PIs involved for greater periods of time, and fewer funds are freed up. The average grant size is going down or staying constant, according to Dr. Posner. Dr. Hagan thanked Dr. Posner, stating that he had answered the HPS query well by describing the details behind the award system.

Discussion
Dr. Ennio Sanchez recalled a previous discussion about the proposal process, in which the possibility of having two phases came up. Now that that process has been implemented, Dr. Sanchez wondered if the first phase might be used as an initial screen leading to a down-selection or an invitation for the most competitive proposals. This would involve a short paper submitted for Phase 1 in order to solicit fewer but longer proposals in the second phase.

Dr. Posner said that the proposal process is still being evaluated. HPD must take into account the mixed feedback in the DS, which called for larger grants. Dr. Giles pointed out that in order to justify any change, there should be a basis for thinking that the change will bring considerable added value. Changes affect and might disrupt the community as they learn how to compete in a new way. Employing the shorter first step has contracted the entire review cycle, which has added value. However, she has not yet seen a model of a two-step review with a shorter proposal and down-select that adds value. Reviewing shorter proposals actually lengthens the cycle, which goes against Office of Management and Budget (OMB) standards. The first review must be robust enough to encourage the right proposals before the community will buy into a change. HPD is not going to do this as an experiment, because the community's employment is involved. The model does not yet exist to prove the added value.

Dr. Jeffrey Hughes said that the shortened first phase followed by a down-select keeps a large portion of the community from having to write a full proposal, though the reviewers must do more. Dr. Giles

countered that the current system provides proposers feedback on why their proposals do not meet the standards, and that is how most panel time is spent: writing feedback. The reviews must be clear, fair, and thorough, especially for younger people. Dr. Newmark agreed, adding that it takes 3 to 4 days to develop coherent feedback. Some parts of NASA do it this way, including APD on its big Guest Observer program. Dr. Giles thought it came down to what principles in peer review are most important to preserve. The peer reviews are difficult and tiring, and new reviewers do not anticipate how rigorous they are. The challenge in finding the balance is identifying the problem that HPD is trying to solve while also deciding upon which peer review principles to maintain.

Dr. Charles Swenson reported that two programs, one in SMD and one elsewhere in NASA, had tried the model under discussion but ended up conducting a full review of Phase 1. He was concerned with ensuring that HPD makes good decisions and the best investment of science dollars. Dr. McPherron added that the shortened Phase 1 would play to the reviewers' personal biases of hot topics. There might also be legal problems, though others disagreed with him. Dr. Giles said the bottom line is that the Division must be able to show it did an adequate review.

Heliophysics Division Comments on National Research Council Decadal Strategy for Solar and Space Physics Report

NASA is putting together a formal, limited response to the DS, reacting to the recommendations. The response must go through layers of review, and will be presented to the community at the winter meeting of the American Geophysical Union (AGU). Dr. Giles presented some of the preliminary ideas that could be included in NASA's formal response, known as the Roadmap.

The three objectives Dr. Giles presented earlier in the day came about with the 2006 HPD Roadmap, were refined in the 2009 Roadmap, and have been consistent since then. The DS goals, while not identical, map well to the HPD roadmap objectives. Consistency is important because when HPD proposes a budget, the Division matches proposed activities to the goals, then maps accomplishments to the goals at end of the year. It is part of HPD's very structure. Having goals that inspire and are easy for a layperson to read and find interesting is very important. Yet there is a difference between the Roadmaps and the DS goals, for the latter are more separated by science area. The overall objective, as mentioned previously, is to "understand the Sun and its interactions with the Earth and the solar system."

There is no indication that the FY14 budget will increase, so HPD will plan to the proposed budget. As the budgets change over time, the Division will apply the principles of the DS, rather than using the document as a specific directive. A graphic showed DS funding preferences through the next 12 years, with the R&A program as the baseline of HPD funding, while the SPP and future LWS programs were at the top of the chart and presumably less crucial to the Division's science priorities. Dr. Giles noted that the DS provides a direction to rebalance HPD's four programs, which is a goal that does not depend on specific funding. It is a move away from absolute values and toward trends. In broad terms, the balancing of priorities puts fewer funds into STP and more into the Explorer budget line. Dr. Art Charo of the NRC explained that the balance argument reflects the need to make progress on all fronts, and is not a move to achieve balance for its own sake.

Dr. Giles next discussed specific recommendations:

1. Complete the current program. The DS committee's recommended program for NSF and NASA assumes continued support in the near term for existing program elements and successful implementation of programs in advanced stages of development.

Dr. Giles thought that was good and expects the Roadmap team to concur.

2. Implement the DRIVE initiative. The recommendation is for implementation of a new, integrated, multi-agency initiative to develop more fully and employ more effectively the many experimental and theoretical assets, up to $40 million by 2024.
    a. A tiny-satellite grants program should be implemented to augment the current Low-Cost Access to Space (LCAS) program, for a combined new-start rate of at least six per year, requiring another $9 million per year for the current LCAS new-start budget of $4 million.

The current funding level supports two to four new starts each year. Dr. Giles believes HPD can do about half of the recommended number, though if the additional funds were available, the full recommendation could be implemented fairly quickly. HPD will have to study this. The budget is tight, and it would be a few years before the Division could ramp this up. The new starts in this area encompass sounding rockets, balloons, tiny satellites, and International Space Station (ISS) payloads that are funded by HPD.

    b. NASA should permanently augment Mission Operations and Data Analysis (MO&DA) support by $10 million per year plus inflation, in order to take advantage of new opportunities from the Heliophysics Systems Observatory assets and data.

Dr. Giles considered this recommendation to be feasible, though the funds might be needed for extended missions. She again pointed to the rebalncing that the NRC advised in the DS.

    c. A directed GIP, at about 2 percent of total future NASA mission cost, should be established to maximize scientific return.

This has been discussed for some time. HPD has set aside funds for Education and Public Outreach (EPO), and this mirrors that concept. One complication is that missions are planned to be complete from end to end. This means that theoretically, during mission reviews, Phase E is supposedly reviewed to be adequate and complete. How, then, does this fit in if everything is accounted for? It is also not clear how the GIP fits in. If HPD has an observatory and people propose for observing time, that is one thing, but many activities are more complex. Dr. Charo offered to find out the intent of this recommendation.

Dr. Newmark asked if this recommendation meant allowing additional people to work on a mission for the funds that the PIs proposed. Dr. Giles agreed that it is difficult to match the GIP to the process. While HPD may need to expand its GIP, this might not be the best way to do that. Even considering the option of having new PIs analyze the data generated by a mission, it is not clear how to implement this. Nor is it clear how development costs fit into the "total future NASA mission costs." In addition, missions sometimes end, or they may live far beyond their plans. HPD will continue discussing this and put together a short-term plan.

    d. NASA should join with NSF and the Department of Energy (DOE) in a program on laboratory plasma astrophysics and spectroscopy, with an expected NASA contribution

ramping up from $2 million, to obtain unique insights into fundamental physical processes.

NASA currently does support this kind of work, though at much less than the recommended $2 million. Dr. Giles's reading of this recommendation is that NASA needs to work with NSF and DOE to get to the right funding level. NASA does some joint solicitations with NSF, though not on a regular basis. Dr. Newmark noted that APD supports this at least as much as HPD does. Dr. Giles said that in solicitations, the decisions are made to go with the best science in the review. NASA believes that it is important to have science areas competed together, instead of having set-asides.

e. NASA, NSF, and other agencies should coordinate ground- and space-based solar-terrestrial observational and technology programs, and expand efforts to take advantage of the synergy gained by multi-scale observations.

Dr. Giles said that this reflects the theme of having the agencies working together better. Both NSF and NASA do ground-based observation programs, while NASA does the space-based programs. The joint efforts are not sufficiently visible to the community.

f. NASA and NSF should together create Heliophysics Science Centers to tackle key science problems of solar and space physics that require multidisciplinary teams of theorists and others, with annual funding of $1-3 million for each center for 6 years, with NASA funds ramping up to $8 million per year.

Dr. Giles explained that HPD has discussed large grants and has done something similar to this. Some SMD divisions do fund centers with "central nodes" where investigators coordinate through them. Institutes like these become established and are less flexible as time goes on. There is also the possibility of the focused science teams in Targeted Research and Technology (TR&T), which constitute an extremely efficient way of bringing together large groups to work on a single problem. These turn over every 3 years. She would like to have more funding for this kind of thing. As for the recommended 6-year duration, she would like to discuss this with NASA's procurement people, as there are issues in the Federal Acquisition Regulations (FARs) concerning the limits of the funding mechanism, specifically whether it can go beyond 5 years, which Dr. Newmark said was the limit.

Another concern was the possible complications of joint management by NASA and NSF. The different agencies have different goals, objectives, and purposes, and it is not always easy to go in a joint direction. NASA and NSF know how to coordinate and have the mechanisms, they just need to make it work better.

g. NASA should consolidate technology funding now in SR&T, LWS, and LCAS into a single Heliophysics Instrument and Technology Development Program (HITDP) and increase current annual funding levels, ramping up to $4 million per year, in order to facilitate innovations required for future heliophysics mission implementation. Issues pertaining to constellations mission implementation should be explicitly addressed.

Dr. Giles explained that there is nothing to consolidate, as it is all in SR&T, which has about $1 million per year for instrument development. The $4 million is not unreasonable over time. Having a separate technology development program comes up occasionally, as there was once such a program. Dr. Hughes said that it is not that easy to weigh the merits of a scientific proposal with a technical development proposal – it is comparing apples to oranges. Dr. Newmark noted that there is a portion of ROSES

dedicated to science-enabling technologies, but there must be science behind the technology. Dr. Spann added that this had been examined elsewhere within SMD. There were problems with the time limits set on R&A proposals, which is a reason to break it out. Dr. Giles pointed out that an investment in a particular technology should be backed up by a need for that technology in an upcoming mission. HPD procures investigations, and there is no guarantee that a technology developed independently will end up on a mission.

Dr. McPherron suggested that the intent of the recommendation might have been to keep some of the engineering skill alive. Dr. Giles said that there are ongoing discussions about what is helpful and mission-enabling in SMD. It is not unheard of for the Office of the Chief Technologist (OCT) to help with funding. A smaller investment could make a big impact in the community.

3. Accelerate and expand the Explorer program.

Dr. Giles explained that alternating small and mid-sized Explorers is something HPD already does. The DS would like to see that budget line augmented by $70 million per year. Ramping that up will take time, but it is the direction the Division has been taking for some time. The availability of new launch vehicles will help.

4. Restructure STP as a moderate-scale, PI-led line. This would be a $520 million lifetime mission cost.

Dr. Giles explained that HPD believes that mission designs should be competed at the time of procurement, and described the process. The 2009 Roadmap prioritized the science the missions should do, and that is when the Division started competing the mission designs with the procurement. This recommendation is what Division management had in mind. Whether it needs to be PI-led is a question, as there is more than one model. SMD will probably have a more formal study of what does and does not work. It could be that this is determined by mission, which would call for more flexibility. When asked why this recommendation mentioned STP only, Dr. Giles said that the DS defaults to small missions as Explorers, medium as being in STP, and large missions as belonging to LWS. However, STP and LWS each have a specific science-based objective, which is important to preserve. Dr. Newmark added that the billion-dollar missions are very complex and do not lend themselves to being PI-led.

5. Implement a large LWS mission to study the ionispehere-thermosphere-mesosphere.
6. Recharter the National Space Weather Program.

These are generally above and beyond the current budget. Just changing the location of the personnel is not going to make people work harder.

Dr. Giles concluded by noting that SMD, the NASA Administrator, OMB, and the Office of Science and Technology Policy (OSTP) had already received briefings on the DS. There was a lot of interest in the recommendations, along with some good discussions.

NASA-SMD Mission Cost History

Dr. Roy Maizel spoke about the factors affecting mission costs and how SMD is addressing cost growth. Recent years have seen cost growth and delays at NASA that were increasingly concerning, especially in light of growing budget pressure from OMB and Congress. SMD therefore created a small group that met

with Aerospace Corporation to identify ways to improve cost performance. A graph of the cost history of about 20 major missions at various phases showed that the greatest cost growth most often occurs between Critical Design Review (CDR) and launch. Aerospace found the same pattern in its own study of 20 missions.

Cost growth is a concern for a number of reasons. NASA resides in the discretionary part of the Federal budget, which gets the most pressure. Although NASA is broadly popular, it is not a "voting issue." The Earth Sciences Division (ESD) budget increased modestly over the last 5 years, while that for the Planetary Sciences Division (PSD) decreased; APD and HPD have been essentially flat. There has been greater internal and external emphasis on cost and schedule control, and NASA is also subject to thresholds for notifying Congress as a result of the NASA Authorization Act of 2005. For example, on missions over $250 million, NASA must seek Congressional approval for further funding once it reaches the 30 percent threshold during development.

The result is a lot more reporting. Congress and OMB get a baseline plan, plus cost and schedule growth reports. NASA must provide reasons for any changes to the plan, and must report on replans and contracts with development content. OMB also wants quarterly updates and notification of changes in contract value. The General Accounting Office (GAO) audits all projects over $50 million. With so many stakeholders, the reporting never stops.

The Agency has responded by developing milestone reviews and performance and program control through Earned Value Management (EVM). GAO wants more specificity at KDP-B, which NASA sees as unrealistic early on in a mission, so the Agency gives ranges. At KDP-C, NASA establishes management and agency baseline commitments to the 70 percent confidence level. EVM includes Integrated Baseline Review (IBR), which is a resource-loaded schedule, and reporting and oversight. Dr. Maizel presented a graph of the project lifecycle cost agreements and commitments, including Joint Confidence Levels (JCLs), which are the probability that the development cost will be equal to or less than the targeted cost. There is a parallel for schedules.

EVM is required for projects with a lifecycle cost greater than $20 million. While EVM is not perfect, it is useful, especially in helping to target interest areas and understanding what is being achieved with financial resources. It integrates cost, schedule, and technical performance. EVM does not measure the quality of the product, however. This is a major limitation.

Recently, missions have been going in the right direction with cost performance. However, the Mars Science Lab (MSL) and the James Webb Space Telescope (JWST) have been problematic, the latter being especially large and complex. Other recent missions have demonstrated cost performance that is quite good. It will take time to determine whether SMD can more firmly conclude that the changed processes have led to the improvement. However, the Directorate has been within range on its new missions. JCL makes SMD budget more realistically.

While the additional scrutiny creates more work, NASA is recovering credibility after a period of not being believed. SMD almost always tests such programs for the Agency because it has the most missions compared to the Human Exploration and Operations Directorate (HEOD) and others. If funds are left

over, SMD is very constrained, but it might be possible to grow the program eventually. If SMD can show that it can deliver on its commitments, perhaps there will be more funds for future efforts.

In answer to a question, Dr. Maizel explained that in a comparison of PI-led missions to other missions, there is no clear trend. However, it might be different if the data were for HPD alone. There would have to be some normalization.

The Effects of Solar Variability on Earth's Climate: Workshop Report

Dr. Karel Schrijver provided an update on this workshop report. The workshop, sponsored by the NRC, was held in September, 2011, with 47 attendees, most of whom were from NCAR. The focus was on three topics: Sun and Solar Variability: Past and Present; Sun-Climate Connections on Different Timescales; and Mechanisms for Sun-Climate Connections. Because of the nature of the workshop, the report cannot include recommendations, findings, or consensus statements in its summary, nor can there be an executive summary. Multiple reviews have slowed down the issuance of the final report, which will have a two-page overview.

The report primarily reflects the workshop agenda, which revolved around the following five questions:

1. What is the most recent and/or most compelling evidence of the impact of solar variability on climate, particularly in the lower atmosphere, over decadal timescales?
2. What can we learn of the variability of solar irradiance using paleoclimate records?
3. What can we learn of climate responses to solar variability using paleoclimate records?
4. Are there any significant climate impacts of solar variability on regional scales?
5. What are the research directions, additional observations, and/or model improvements necessary to improve understanding and forecast ability regarding solar variability and climate, particularly over the solar cycle timescale?

There was a lot of resistance from recent climate modelers to include sun effects, possibly because they have worked so hard to show human causation of climate change. Questions 2 and 3 were both linked and difficult to address. The consensus for the fourth question was "probably yes." Finally, the workshop did not result in much in the way of research directions.

Dr. Schrijver reviewed the research rationales for the workshop, centering on whether solar output has has measurable impact on Earth's climate in the last 50 years, identification of the mechanism for any such impact, and the utility of such information to researchers. Dr. Schrijver said that he is not as concerned with the need for calibration, but does see the need to establish the impact of the activity and extend it to the historical climate record. It is important to understand the climate proxy that now exists for Western Europe and other temperate regions. The records are not substantial enough, and the field should be talking collectively with the climate scientists about this. Climate modelers bring up Earth-related data about phenomena like volcanoes. But there is a need to show what occurred years ago in order to compare and determine the influence.

Discussion

Dr. Lika Guhathakurta added that this workshop was in development for a long time. The field requires examining the paleo-data to show the Sun-climate connection. It is exciting because when there are new

results, it is not clear what they will be. The climate modelers are doing much interesting work. ESD does some of this, but the goal of the workshop was to create a community of solar-physicists and scientists, and boost their efforts. Dr. Hagan noted that the DS mentioned this area as well. Dr. Guhathakurta said that field would benefit from bringing in some of the scientists and modelers from the Sun-climate community to work on the Explorer projects that examine climate coupling. Dr. McPherron observed that when he participated in an earlier Sun-climate conference, he got the impression that it is hard to communicate the very small effect through complex models that are in turn hard to prove. Dr. Guhathakurta said that some of this has been seen with Venus, which has led to the idea of trying the climate models on other planets. Dr. Spann told of another conference where the participants tried to quantify the variability of the Sun. He left the experience feeling like the quantification is in the noise, to the point where it is not a significant driver of climate.

Dr. Charo explained that the workshop was initially cost constrained and did not screen the participants for expertise, which is why were not allowed. NSF saw this as something that could maybe lead to a larger effort, but the only people who expressed interest were in HPD. This is also a hot political topic. Dr. Schrijver agreed with Dr. Charo's characterization of the workshop. A full study has an actual task to identify what is and is not known, which was beyond the scope of the workshop. He wondered if it might be productive to approach the problem from a different perspective. A lot of effort has been put into understanding what is seen in the heliosphere and solar corona. Climate modelers do realize that there was once more influence from the Sun, so it might be possible to engage them more constructively by not addressing the last century.

Dr. Hagan asked if there was discussion of gaps in our observational knowledge, and whether there may be processes that are not well understood and observables that might provide insight. Dr. Schrijver said that there was no consensus view, but most missions are short-lived, and continuity from one to the next is problematic. The climate modelers are interested in differential absorption. Dr. Charo noted that with the failed launch of the Glory mission, there are attempts to get another mission that can connect the records. There is another workshop that might look at use of other data sources and modeling. Dr. Guhathakurta noted that there is no reason for HPD to do this alone. There is a need to continue looking, because there are too many unknowns, such as what the measurements should be. Dr. Schrijver added that the interested scientists must also show that there is something worth measuring.

Subcommittee Discussion

With time left at the end of the day, Dr. Hagan held a discussion session for Subcommittee members and those presenters who remained in the room. Dr. Posner provided some additional information based on questions that arose during his talk in regard to the average award sizes for competed R&A programs. In real-year dollars, not factoring in inflation, the awards have been essentially flat. Dr. McPherron noted that there has been a long-term trend in universities to charge more and more against the grant, and Dr. Newmark observed that it is widely believed that the cost of doing business has gone up. Research universities, private sector firms in the field, and government labs have all increased their costs.

Dr. Hagan then suggested that since the Roadmap is essentially a product of HPS, they should think about how they can help the Roadmap team. Dr. Ed Deluca, who was to give a presentation on the Roadmap the next day, said that the basic point was to be that the next Roadmap will look a lot like the last one, from

2009. The latter was seen as useful and well-constructed, and the team will use its structure, especially since the timeframe for completion is brief. The team solicited input from the community electronically, and those comments will appear in the appendix. One reason for this approach has to do with the recent release of the DS, which had 2 years of community input. There will be a town hall at the AGU, but by then the document will be mostly complete, if not entirely so.

Dr. Deluca's presentation was to bring up the issue of the relationship between the 2009 research focus areas and how those map to the science goals and challenges of the DS. Dr. McPherron did not see how it could all be mapped into the flat or decreased funding. Dr. Newmark said that understanding the budget is difficult, and that the DS sought to move the Division toward the optimal mission profile. The percentages are what matter, and they change over the life of the DS timeline. As Dr. Giles said in her presentation on the DS, the NRC recommended a relative reallocation of HPD funds to have STP go from 30 percent of the budget to 21 percent, with the Explorer program growing from 12 percent to 21 percent. Dr. Spann added that in 2024, the DS has strategic missions at half the budget, versus more frequent missions also accounting for half the budget. Currently, the split is 2/3 versus 1/3. Dr. Deluca explained that while the DS did not emphasize articulating the distinction between STP and LWS, the Roadmap committee is doing that. Dr. Newmark noted that in the DS decision rules ranking the funding priorities, LWS is delayed should there be insufficient funds.

Dr. Charo told the Subcommittee that NRC convened a splinter group on SPP, as NASA asked for input regarding whether to revalidate the mission and, if so, what decision rules might apply. The decision rule was that if a mission runs over in Phase B, NASA should convene a review. NASA agreed. Dr. Swenson expressed concern that he had seen no numbers on SPP, which is big, growing, and holds the potential to cause problems. Dr. Charo explained that 2 years ago, the estimated cost increased due to launch vehicle expenses shooting up. Drs. Newmark, Hagan, and Swenson all expressed concern about how to address a situation in which the costs look like they will increase. Dr. Desai noted that costs at the time of proposal are academic; true costs come into view around the start of Phase B, which is where SPP is now. Dr. Swenson was concerned that the new system will not provide the desired cost controls.

Dr. Hagan asked the Subcommittee members to think of specific questions for the next day, and adjourned the meeting for the day.

Thursday, October 11

Heliophysics Roadmap for Science and Technology 2013-2033 Status

Dr. Deluca explained how the Roadmap team planned to prepare NASA's response to the DS. The team is an advisory group to HPS, with a scope of 20 years and a charge to be consistent with budgets and budget assumptions. The DS covers 10 years, and some of its recommendations affect organizations outside of NASA. The team's charter is to align the DS science strategy with the NASA Heliophysics program, crafting a sustainable science program that is achievable within HPD resources and constraints. The last Roadmap was developed in 2009, when the economic downturn had begun but the budgetary implications were not yet known. The lunar science initiative was very active at that time, for example, but has since been set aside.

The DS covered science, missions, and inter-agency relations. The specific missions were not detailed, but the report laid out costs, technology readiness, and measurement requirements for the science it recommended. The Roadmap will align the science strategy of the DS with the Heliophysics program over the next 10 years, then extend the strategy to 2033. The Roadmap will also identify needed technology development.

Some decisions have already been made:

- The Roadmap will follow the science priorities of the DS, making R&A and the DRIVE program the highest priorities for new funding;
- The Roadmap will follow the mission profiles of the DS; and
- The Roadmap team will solicit community input via Quad-Charts, seeking them from the DS lead authors.

There were 300 white papers submitted to the DS. The Quad-Charts will be used as a way for the community to show their ideas and the driving elements going forward for all Heliophysics, not just for missions. Dr. Giles added that the charts are used extensively by other parts of NASA to see what HPD is interested in doing. When someone is looking for trends rather than looking at single strategic missions, they are a good reference, as some mission planning activities go out 30 years. Quad-Charts provide a preview of what the community could propose in the future. Dr. Deluca explained that the charts from last time will be pulled forward into 2012 Roadmap, with updates as appropriate.

There was discussion about how best to communicate with a community that is pressed for time and receives many electronic communications. Options included Solar News and Space Physics and Aeronomy (SPA). There will also be a Roadmap blog and web page. It is also possible that the deadline for the Quad-Charts will be extended.

Additional decisions the Roadmap team has made include the following:

- Keep and expand the Research Focus Areas (RFAs) from the 2009 Roadmap. The team will map the DS science questions and mission profiles to the RFAs. New science drives expansion of the RFAs, which will be modified as needed.
- Keep, with some modification, the 2009 definitions of the STP and LWS mission lines.

The focus of the STP missions follow the 2009 definition: “The STP program explores fundamental solar and space physics processes occurring within the solar system, and how they affect the nature of our home in space.” The DS recommends that STP be structured as moderate-sized PI-led missions. This will allow for the required launch rate, given expected budgets. Dr. Deluca sought HPS insight on how to merge the lines. The team believes that the statement about size is an implementation strategy in the face of the budget, rather than a change in how HPD defines STP mission lines.

Dr. Deluca explained the current status of the Roadmap, stating that the team has assigned writing, submitted the initial text for Chapter 1 submitted, and drafted definitions for STP and LWS. Dr. Desai made some suggested changes, and the following working definitions were discussed:

> *"STPs are PI-led strategic missions that fill gaps in the linkages across the interconnected Sun-Heliosphere-Earth system by providing fundamental understanding of the underlying physical processes and how they affect the nature of our Earth's home in space. The goal of these missions is to understand the processes that determine the mass, momentum, and energy flow in the solar system from the Sun to planetary bodies, including Earth, to the interstellar boundary and its interaction with the local interstellar medium."*
>
> *"LWS missions are strategic missions that emphasize a system-wide approach to the fundamental science that is necessary to unravel those aspects of the interconnected Sun and space environment or its major components that most directly affect life and society, with an ultimate goal of enabling a predictive understanding."*

Dr. Giles questioned whether these and the Explorer programs should be PI-led. The point of the program is to procure missions, with an emphasis on science goals. These definitions are the descriptions in HPD control documents, and the procurement mechanism might be best off in a different area.

There was discussion about the differences between STP and LWS. Both look at fundamentals, but LWS is more system-wide, though that may mean different things to different people. Dr. Desai agreed to work on the wording further. Dr. Giles said that these missions do all kinds of science. STPs work at understanding specific problems that are fundamental to space and solar physics, as MMS is focused on magnetic reconnection. LWS targets science that most affects life and society.

Dr. Deluca next talked about science alignment issues and process. The Roadmap team recognizes that rewording top-level science questions is important, as these appear in multiple NASA documents. That task is pending while work on the first chapter continues. He explained some of the details of that chapter's development. For example, the role of HPD in space weather needs to be clarified, and the relationship with the National Oceanic and Atmospheric Administration (NOAA) needs to be defined. The team will continue to use RFAs as the descriptors of the science goals, and will do a matrix of the text, RFAs, and side goals. The team will also use DS challenges and science questions as the metric for the traceability matrix to the missions. The back of the Roadmap matrix includes mission descriptions. There will be references to the RFAs in the traceability matrix. He showed some sample charts of how the team might map the RFAs to the DS goals.

Dr. Deluca also showed a draft of the traceability matrix, using the Atmospheric Ionosphere Magnetosphere Interactions (AIMI) mission to show how open issues and priority questions will help identify gaps at the mission level. This goes back to the last Roadmap. Another sample matrix mapped HPD assets to DS priorities. Sometimes the DS goals and priorities were not consistent, so the Roadmap team studied the panel reports that form the background for the DS. It was suggested that one problem facing the team is that the DS as written does not lend itself to front-to-end traceability, meaning that the team will have to develop it. After further discussion about the Roadmap matrix structure, Dr. Deluca agreed to reorganize the draft according to the HPS suggestions.

Outstanding issues for the Roadmap include the role of NASA Heliophysics in space weather, and cost containment strategies. When Dr. Deluca asked for guidance in addressing latter, Dr. Giles suggested

referring to the previous day's discussion of cost management. Another outstanding issue is competition for PI-led moderate-sized missions. The Explorer line is very competitive because the mission objectives are only restricted by the Heliophysics RFAs, and the complexity is limited by the cost cap of about $250 million. For a focused STP mission, the question is whether more than two institutions can put forward competitive proposals for a moderate-sized mission of about $500 million.

Discussion
When it was suggested that the document define terms such as "objectives", "goals", and "challenge," Dr. Deluca explained that the Roadmap must reference back to the previous versions. The Roadmap must be consistent within itself, regardless of how the DS describes things. Dr. Giles agreed, adding that the Roadmaps have been consistent among themselves over time, which is a good trend. She did note that one of the first things Dr. Deluca did was explain the Roadmap team's differences with the DS, and those differences are a concern. There is a new and exciting DS, and the Roadmap should reflect it rather than focus solely on being like previous Roadmaps.

In discussing how to reconcile the two, Dr. Hagan observed that trying to map the DS goals to the RFAs is difficult. Dr. Giles agreed, and noted that there is no top-to-bottom traceability in the DS, which is what NASA must have when constructing a mission. Dr. Newmark said that the DS had panels that worked in evident isolation, and the steering committee put the questions together from the panel reports. He saw the primary variables as the old RFAs, the 12 challenges copied in Section 1 of the DS, and the questions in the subpanel reports. Dr. Swenson added that the DS emphasized priority and implementation strategies more than the science questions HPD had sought. The Subcommittee then worked with Dr. Deluca and the NASA personnel in the room on an exercise to create the kind of flow and traceability they all sought. It was agreed to return to this issue after a short break.

Upon resumption of the session, the issue of terminology came up again. Dr. McPherron had the impression that portions of the DS were not coordinated and therefore did not use consistent terminology despite the fact that continuity of terms is important. It was agreed that the Roadmap will define its terms. The Subcommittee members and other meeting participants developed the following draft mission lines definitions for Dr. Deluca to take back to the Roadmap team:

- The **Explorer** program contains focused missions that address highest priority exploratory or new scientific questions identified by the scientific community. These are frequent and agile missions that fill a critical role in advancing our understanding of Heliophysics.
- The **Solar-Terrestrial Probes (STP)** program contains strategic missions designed to understand fundamental universal processes that determine the mass, momentum, and energy flow within the solar system. These missions probe the most critical unsolved physical problems in the Heliophysics system.
- **Living With a Star (LWS)** missions are strategic missions that adopt a systems approach to understand how the Sun, heliosphere, and near-Earth environment interact to influence life and society, with an ultimate goal of enabling a predictive capability.

On the STP definition, discussion focused on the second sentence, specifically about the breadth of the missions and what they probe. HPS did not come to consensus, and took it off line for further work. On LWS, there was discussion about the use of the word "system." Not all missions look at a system, though

the program does, and this issue generated considerable debate. Dr. Giles described HPD's efforts to keep STP and LWS distinct. The Roadmap language is not in all of the control documents, which accounts for some disconnects. She is seeking consistency in the language in order to prevent further confusion. Dr. Deluca was satisfied with the guidance he received in this area.

Work resumed on mapping and traceability. Dr. Deluca showed a revised sample table that accounted for the RFAs, the DS science challenges, open issues and priority questions, "in flight," development, the next priority, and the future. The example used Magnetic Reconnection, which he chose because it is not his area. The example was close to what the Subcommittee sought, and after further discussion and edits, it was agreed that the table indicated a good direction for the Roadmap team to take.

Other issues raised in relation to the Roadmap had to do with addressing cost containment strategies. Dr. Sanchez pointed out that there is a great need to keep cost overruns from jeopardizing other missions. Dr. Deluca said that that was on the Roadmap team's agenda, but they had not discussed it yet, and he did not have a sense of what the team members thought. In the 2009 Roadmap, cost containment was addressed in Chapter 2, and he heard that people found that useful in identifying threats. It was suggested that the Roadmap include the Future Enabling Budget Scenario slide from Dr. Giles' presentation about the DS. This slide showed the priorities proposed by the DS. Dr. Deluca agreed that the Roadmap team would begin by adopting the DS bottom-up approach of funding the lower sections first, then moving up as funding allows. He was open to discussing the threat of cost growth in the Roadmap, though he did not think it would be a good idea to single out individual missions. It was generally agreed that NASA management is aware of this issue.

There was some frustration expressed regarding the growing costs related to SPP and the lack of clarity as to what caused those increases. Dr. Deluca said that he has long been concerned about the fact that it has been stated for many years that the R&A program is important and should not be raided, but HPD has been unable to protect it. It is always first on the chopping block. Dr. Hagan replied that in that context, the decision points in the DS are attempting to put teeth into that strategy. Dr. Judith Karpen suggested referencing that point in the Roadmap. Dr. Giles explained that the shifting of funds from R&A can happen at many levels. Dr. Swenson recommended describing the R&A program and explaining carefully how the other programs fall apart without R&A, and why it is necessary and fundamental. Dr. Deluca agreed, though he was inclined to reference the proportional pie chart from Dr. Giles's presentation on the DS. In discussing the source of extra funds for projects that go over budget, it was explained that rather than helping, delays might exacerbate the problem, depending on the phase. It was recommended that the Roadmap outline priorities so that the implications of delays are clear.

Dr. Hagan asked the Subcommittee members to consider how they might want to word any findings, which they would discuss the next day.

Heliophysics Senior Review Guidelines

Dr. Jeff Hayes, Program Executive for MO&DA, discussed the upcoming Senior Review, which will encompass mission operations from FY14 to FY18. Missions must provide the Review a set of Prioritized Science Goals (PSGs) that cover the next 5 years. Increasingly, government managers want lots of metrics to show good value for the dollar, and to that end, the Senior Review wants to be able to show

science goals that the missions can map back to. The Review will seek flexible options, providing both on- and off-ramps to allow for cuts or increases across funding ranges. Missions have been asked to identify the science compromised or lost if their budgets were to be decreased by 5 percent or more. Those missions with an EPO program will be included in the Senior Review proposal. The Review will capture labor levels for civil service and contractor work in mission operations, as well as in the science operations and analysis aspects of each mission. In addition, the main part of the report on the science and technical aspects of the mission is set to a page limit of 30, though that does not include mandatory appendices, the acronym list, and the budget sheet.

The current draft of the Senior Review was issued knowing that there were some unresolved issues. However, it was decided that the draft was necessary to obtain both community and HPS feedback. At the last HPS meeting, there were concerns about the evaluation criteria, specifically regarding science per dollar. Dr. Hayes had no algorithm for that, and while he saw the difficulties with the term, he noted that it allows the Review panel the broadest flexibility in making assessments. The science per dollar evaluation assumes the status quo operationally, and also assesses cost efficiency, data availability and usability, and vitality of the mission science team as secondary evaluation criteria after scientific merit. The bottom line is that the Senior Review does not shut off good missions. The Review is also assessing the MO&DA portfolio to determine how well the individual missions contribute to the Heliophysics System Observatory (HSO).

Proposed new criteria include the following:

1. Scientific merit: This is based on the PSGs. The panel can evaluate scientific merit both for standalone activity and in context of the HSO.
2. Scientific implementation merit: Missions describe how they will achieve the PSGs.
3. Technology, management, cost: This is a standard activity.

The Review panel is uncertain about weighting, which might not be that useful given that the missions were chosen at different times under different criteria and are therefore very heterogeneous. There is a need for programmatic flexibility.

Discussion

The Subcommittee began discussing the pros and cons of "science per dollar" as a criterion, generally agreeing that it is difficult if not impossible to measure this due to the fact that it is a subjective element. Nonetheless, there must be criteria for deciding what to do when a mission is looking for an extension. There was some concern that the "scientific merit" criteria might be similar, however. Dr. Newmark explained that the intent was to allow maximum flexibility and let the mission teams explain what they want to do. Dr. Hayes said that there are missions where hardware is just providing data, and there may be funding for archives. Yet the scientists who began the mission might no longer be available to scientists trying to work with the data. This could make the science less useful than it might be otherwise.

Dr. Desai said that it is hard to predict when a researcher will want to use past space data. He suggested creating a metric to gauge how much and the extent to which past data are used. Not every mission will be easy to judge in this regard. Dr. Hayes said that while he agreed with part of this idea, he did not like

the idea of the Agency dictating metrics. He was also concerned about manipulation, which would be possible with this concept.

Dr. Swenson observed that HPD is trying to do quite a lot, and the long data record provided by some missions constitutes a contribution. Other missions can accomplish more than the goals of their original missions. He thought that what might be missing was a science plan for the HSO. He would like to see several senior people write such a plan, which would then offer an idea of the contribution of each resource to the HSO. To ask the individual missions to do that creates quite a patchwork. There is also a need to weight the science value of keeping each mission going, compared to the MO&D budget.

Dr. Hagan thought there was value in having the missions give their perspectives of how they fit into the HSO, even though it would reflect many different priorities. That is what the Review panel is charged with doing, contrasting the different perspectives. It was noted that the existing document about the HSO is out of date. Dr. Giles said that if there is not a clear idea of what the HSO should be after the Senior Review, then maybe it will not be a criterion for this iteration. Dr. Hagan had heard both praise for the idea of gauging scientific merit and reservations about measurement strategies. Dr. Newmark said that the Senior Review panel was trying to allow flexibility for the missions. Some missions might not have data analysis beyond the mission operations, and will need the opportunity to show their importance.

Dr. Swenson noted that funds from the operations of existing programs were used to create the GIP, and he wonders if that went too far. His concerns were both balance and loss of expertise in the data stream. Several suggestions about how to conduct the GIP were proposed. Dr. Deluca spoke to the value of papers in refereed journals as a useful metric, noting that the organizations behind the journals have standards that NASA has endorsed. Dr. Hayes agreed, stating that it is essential to track refereed journals in order to track archival science. Dr. Desai cautioned that citations are not always a good metric, as some bad papers are cited a lot.

NAC IT Infrastructure

Dr. Larry Smarr, chair of NAC's Information Technology Infrastructure Committee (ITIC), spoke to HPS about mutual interests. ITIC has a broad membership, and Dr. Smarr is involved in IT activities at other agencies as well. Compared to other agencies, NASA is not an IT leader, which is a concern. ITIC is drafting a recommendation for NAC, the current draft of which reads, in part: "NASA should formally review the existing national data cyber-infrastructure supporting access to data repositories for NASA SMD missions."

The growth in the amount of data storage for SMD has shot up quickly. There are a lot of individual servers, as each mission has its own. More and more science publications are coming from reviewing the data archives, and the growth is rapid. The public loves NASA science, as shown by interest in social media and apps that make data available to the public in various forms. Public support for NASA makes the science possible. Specific to HPD, the solar community does the most forward-looking simulations.

This is a software challenge that will increasingly affect those doing data analysis. There is a vast amount of data that can move quickly in an infrastructure that is not now available to NASA, but which would be quite beneficial for SMD missions. Dr. Smarr showed a model for the future, with large data freeways

enabling movement of data more quickly. The NSF Ocean Observatory initiative is probably the best example of uniform architecture that can serve science, education, and the general public all at once. NASA lacks the appropriate visibility in the IT area, but ITIC believes that SMD ought to be the locomotive for having a strong data infrastructure at NASA.

Discussion
Dr. Swenson sought clarity on a couple of points. First, there was the idea of distributed data, with each mission having its own computing and storage center as opposed to a centralized system. Dr. Smarr said that the real concern was more about connectivity. The study ITIC proposes would look at how things have been done, and would compare data across missions, looking at the infrastructure that sits between the "smart nodes."

Dr. Swenson's second question was about the large data centers, which HPS had discussed. The Subcommittee has been concerned that the profession needs more people to analyze data, which is of greater importance than hardware on which to do analysis. Dr. Smarr thought this was a good point, noting that NSF used to have more such people. The people-to-hardware ratio has been shifting to the hardware side, which he believes is a mistake. He added that something like 50 percent of NASA's supercomputer capacity goes to SMD analysis, a much larger ratio than in the past. This is mainly for computing the output of scientific instruments, whether space satellites or next-generation simulations.

Dr. McPherron explained that he uses historical records in data analysis and encounters problems just trying to get data. They are in various formats in multiple centers with different interfaces and storage. A great amount of his time goes into making data usable. He has had issues finding where the data are to begin with; his main problems are with accessing data. Dr. Smarr said that this is software engineering and shows what kind of reform NASA needs in software architecture. Dr. McPherron should be able to find and download data easily.

Dr. Newmark identified two issues. First, NASA does modeling at Headquarters. Second, there is also the connectivity from place to place. He asked if Dr. Smarr saw these as intertwined with global connectivity or whether they are separable. Dr. Smarr said they were separate issues. Connectivity of supercomputers has plummeted. Recently, two NASA Centers tried to talk to each other about hurricane prediction. They made it work, but the connectivity issue was like that described by Dr. McPherron, where the systems are not comparable. The goal of the recommendation is to strengthen connectivity. The study would look more at making the data available.

Dr. Karpen said that she was surprised not to see DOD mentioned, given that the Naval Research Lab supports simulations of solar activity. The lab provides very good capability and good support, to a much greater extent than NASA does. NASA has not paid attention to staying with the state-of-the-art in high performance computing. The Heliophysics community also needs large-scale data processing and high-capability equipment for studying space weather. Dr. Smarr agreed with all of her points. Space weather is very complex and large, and the data must be integrated. Dr. Smarr thanked HPS for their feedback, which will help focus ITIC's effort. He will speak to the other science subcommittees for further input.

After Dr. Smarr left, Dr. T. Jens Feeley, Executive Secretary of the NAC Science Committee, asked HPS to consider if the proposed study warrants pursuit and, if so, to identify the concerns, areas of focus, and outcomes that should or should not be included. He believed that NASA would do the study and report back, though that was not certain.

NASA Launch Services Briefing

HPS invited Mr. Jim Norman, Director of the Launch Services Program (LSP) at Headquarters, and Mr. Darren Bedell, Systems Integration Manager for the LSP at Kennedy Space Center (KSC), to give a presentation on launch services. Launch costs are growing and have a significant impact on the total cost of missions.

Mr. Norman explained that most LSP staff are based at KSC, though the Program reports to him. Among the Program's responsibilities are inspections for compliance with NASA's policy on certification. LSP interfaces with the National Reconnaissance Organization (NRO) and the Air Force, among others. Mr. Bedell presented a list of certified launch vehicles, pointing out that just because a launch vehicle has the same first name, like "Falcon," does not mean it is the same as others with the same name; the vehicles fly somewhat differently. He pointed out some emerging vehicles like the Delta IV, which is not yet available for NASA but has been approved for DOD. The vehicle supplier decides whether to make a specific vehicle available to NASA, so the manufacturer has chosen not to allow NASA access to the Delta IV at this time. If that decision were reversed, it might take 3.5 to 9 months before the vehicle could compete with other launch vehicles. NASA considers the launch vehicle's flight history and processes, including data and input from NRO and the Air Force. There are procurement issues, as well.

Mr. Norman explained that new vehicles come in via an annual "on ramp" process. In 2011, three providers brought in vehicles; in 2012, there were none. To be brought onto a contract, launch vehicles need to be made by a U.S. company, they must be ISO 9000 certified, and the manufacturer must provide verifiable cost numbers. That gets a vehicle from "emerging" to "not yet certified." To be certified, the vehicle must demonstrate a successful first flight for any U.S. entity. LSP then evaluates the proposal and the plan to become certified. There are multiple launch vehicle configurations, and NASA does not have the resources to certify all at one time.

Missions are classified by risk, with D being the riskiest. Most science missions are class A, B, or C missions; Explorers are Class C. Mr. Norman reviewed the class sizes, noting that procurement is based on pre-negotiated not-to-exceed contracts, which help from a budget standpoint. The Human Exploration and Operations Directorate (HEOD) supports LSP with a budget of about $80 million per year. Customers pay for the launch of a specific mission, with basic launch services accounting for 80 to 90 percent of the launch cost, and telemetry, integrated services, and mission-unique services making up the rest. These additional services can make it appear that LSP pays more than the "Internet price," but NASA negotiates a considerable number of other elements, so that the total LSP price is usually significantly less than the sum of the off-the-shelf parts. For example, the contract does not include certification costs, as it is left to the provider to decide whether to bid for NASA certification in the first place. NASA also provides some bundling and efficiency that other entities lack.

A comparison of total mission costs from 1999 to the present shows the extent of the cost increases, most of which are in the form of ranges based on mission size. Actual prices are likely to be at the low end, but LSP seeks the best value selection, not just the best price. The over-arching question during procurement centers on the level of risk. Lower risks equate to higher costs. Some of this is what LSP providers believe the market will bear – these ranges are set by them, not NASA. There are also huge performance ranges, payload weights, etc.

Mr. Bedell showed normalized launch service pricing across various types, noting that these prices did not escalate much from 2002 to 2012. During that time, DOD was also buying rockets without the infrastructure payments that NASA had. In one example, the prices rose by about 3.5 percent each year, while some of the producers dropped out. Dr. Giles pointed out that RBSP came in affordably, thanks to LSP. Mr. Norman explained that Boeing and Lockheed had good products but left the market due to an insufficient number of launches in the early 2000s. Now the Air Force is engaging in a "block buy" strategy, which could delay competition within DOD. NASA has a clause saying that the Agency can get whatever price the Air Force gets.

In the Medium class, there was a small price decrease in 2002. But the possibility of Delta II leaving the market led to a block buy of 19 of those vehicles, and the infrastructure costs were not passed on to spacecraft use. Full cost accounting is now showing that, as the Delta II configurations include infrastructure. The Falcon 9 market range includes infrastructure and is below Delta II costs. The overall message is that rocket costs have gone up over time, NASA is doing direct pay now, and the Agency is getting a good deal from the current providers. The cost increases should not surprise anyone.

The key message is that there is a myth that there is a large LSP tax on NASA launch services. The estimates reflect what missions most likely need to pay. LSP does not keep extra funds, but instead returns them to the mission's program. Dr. Giles confirmed that this has happened with HPD. Mr. Norman said that prices have increased due to market forces in intermediate-class launch services. Competition will cause it to normalize, but NASA will never return to 2000 costs. Medium-class launch services costs are either at or below "normal" escalation projections, while the small-class launch services situation is under review. LSP looks at both lift and price point capacities. LSP will keep working to provide value and successful launches. Current market conditions have delivered a new medium-class vehicle with both initial success and a price below Delta II prices.

Discussion

Dr. Giles thanked Mr. Norman and Mr. Bedell for the thorough review and the useful charts. Dr. Swenson asked about the tiny satellites recommended in the DS. It was explained that LSP is pursuing and has procured multiple cube-satellite opportunities. Such opportunities have always existed but tended to be ad hoc. Regarding different sizes, standardization would make procurement and economical pricing easier. The launch costs for secondary missions can be discussed further with the LSP office. Mr. Norman added that the orbit is a factor. Low Earth Orbit (LEO) is one thing, but anything else will bring added costs.

<u>Subcommittee Work Session</u>

Dr. Hagan suggested three topics to address the next day:

1. Response to Dr. Hayes regarding new recommendations for criteria for the Senior Review;

2. Response to Dr. Smarr regarding whether HPS wants to endorse a NASA self-study on IT infrastructure and, if so, the scope and focus that will be most valuable to HPD and the community;
3. A comment on cost control.

Dr. Desai said that he and Dr. Karpen would like to see a broader picture of past heliophysics missions to determine where they broke down in terms of cost. This would mean requesting more information in order to eventually develop a recommendation. Dr. Hagan said that Dr. Giles can provide that at the next meeting. Her concern was input to the Roadmap, which will include a statement about cost control. The Roadmap is ultimately an HPS document, and she would like to see the Subcommittee try to guide it.

Dr. Hagan suggested forming teams to work on the topics. The assignments were:

1. Dr. Strachan was to develop the recommendations for Senior Review criteria, with input from Drs. Desai and McPherron;
2. Drs. Karpen and Hughes were to lead the IT study response, with input from Drs. McPherron and Swenson;
3. Dr. Karpen was to write a comment on cost control, with assistance from Drs. Desai, Swenson, and Sanchez;
4. Dr. Swenson was to write a letter thanking Mr. Norman and Mr. Bedell for their presentation.

Friday, October 12

Subcommittee Work Session

Senior Review

Before beginning a writing session based on the assignments of the previous day, there was discussion of the previous Senior Review, which was available on the NASA website. Dr. Swenson said that it would be useful for the missions going to the Review to follow a consistent format in writing their reports for the Review, so that the reports can be easily mapped. He asked if it was clear what the Senior Review ratings mean, and whether a single weakness could significantly lower the score of an otherwise stellar project. Dr. Hagan said that she heard Dr. Hayes say that he was not in favor of a prescribed weighting system, as it did not allow for flexibility of judgment.

There was discussion about science per dollar evaluations in the previous Senior Review, as well as relative capabilities of the missions. Dr. Strachan explained that his team identified elements that should be under Dr. Hayes' concept of the key three criteria: scientific merit, scientific implementation, and technology management and costs. Dr. Swenson wondered whether squeezing money to extend missions was the best overall approach to HPD. He reiterated his concern that the HSO program has not been studied from beginning to end across missions to see what and how the missions contribute. Dr. Karpen noted that part of that was being done under LWS. Dr. Hagan suggested calling in Dr. Deluca for more information. It was agreed that the concern with the proposed finding was the statement about the weight.

Dr. Strachan noted that there was agreement that the current science per dollar criterion is hard to define. He suggested providing some considerations without dictating what needs to be done. Dr. Desai added that some missions have a broader impact beyond their own area, which is also hard to measure. Dr. Swenson pointed out that it is not practical to cancel a mission that has not resulted in many published papers because the money to do the right science was not there in the first place. Dr. Newmark explained that the mission representatives will have the opportunity to make that point. They can say what their prioritized science goals are and whether they met them. If they are not meeting their goals, they have an opportunity to explain that. Dr. Swenson expressed concern that the better presenters would get the better scores, given that the Senior Review panel has very little time to actually review the issues.

When Dr. Hagan asked if the Subcommittee members thought there should be a recommendation about weighting, the discussion that followed led her to conclude that there was not consensus for a recommended weight. She asked for specific proposals. Dr. McPherron said that the mission must justify the science in part by explaining how others can use it. The issue arose of whether the instruments work as planned; there must be healthy instruments to flow the data to the data team. The technical merit therefore is not separate from science implementation. Debate continued about the measurement of value, science implementation, and data. Dr. Strachan observed that the goal was to add flexibility, but the discussion made it seem unwieldy.

Dr. Swenson explained that he would have liked to have had the Senior Review panel develop a plan and present their priorities to HPS, because HPS cannot really design the Review process beyond just stating what the members value. Dr. Newmark suggested that this would mean identifying both the factors the panel should think about and the values HPS sees from the science community. However, it was also important for the panel to focus on how to make the most scientific progress. Dr. McPherron said that the panel should maintain mission where there is any value to the data, and put the data where it can be used. The real danger is when the mission team only processes the data they value instead of archiving everything. It then becomes worthless to all but the original investigators. Others agreed with his thought that usefulness of the data to the community at large should be a criterion.

After more time for thought and writing, Dr. Swenson presented the following draft finding on the Senior Review:
"The HPD should maintain the following values and concepts when implementing the Senior Review and managing the MO&DA program.

1. Missions in extended phase should be asked to separate the costs of obtaining, validating, calibrating, and archiving data from the costs of completing science investigations with the data obtained.
2. The archive of calibrated and publicly accessible data for general use by the science community from the broadest number of missions is of the highest importance. Greater risk in obtaining data is acceptable if substantial cost reductions in mission operations can be achieved.
3. Each team is expected to accomplish scientific investigations above basic archiving of data.
4. The Senior Review shall evaluate the scientific merit of each mission's extended phase science proposal.

5. The Senior Review shall evaluate the health of individual scientific instruments and the relative importance of the data to the objectives of the HSO.
6. The Senior Review shall evaluate the technology management and total cost of missions in the extended phase relative to the value of the data to be archived to the HSO.
7. The HPD shall enable members of the scientific community to use the HSO for achieving systems science investigations and to develop continued expertise for the ops and data processing of the existing missions.

There was some debate about the final point, with regard to use of data by the science team versus others in the community. It was agreed that that point would be edited for clarity. Although there was not consensus on specific criteria, Dr. Hagan thought the piece was valuable in giving guidance to the Senior Review team.

Debrief with the Heliophysics Division Director

Dr. Hagan thanked Dr. Giles and her team for the informative presentations. She explained that the Subcommittee was taking forward four items, and wanted Dr. Giles's feedback.

1. HPS was impressed with the LSP presentation, and developed a finding thanking Mr. Norman and Mr. Bedell: "HPS commends the LSP for their exceptionally clear presentation on the current and historical costs of launch services. It is clear that HPD and SMD receive the lowest possible costs for its missions."

Dr. Giles concurred with this point.

2. HPS was not ready to present the Senior Review recommendations, and was unable to reach consensus on the proposed criteria that Dr. Hayes discussed. There was significant concern about scientific implementation and technology management, as well as a problem in ascribing weights to each of the criteria. Dr. Swenson was working on a draft of guidelines for the Senior Review panel, which had not yet been approved by the Subcommittee. He read the above draft points to Dr. Giles, emphasizing that these were values and concepts.

Dr. Giles replied that not all of the concerns were new to her. There is an issue of requirements from the prime phase being revised to save money. There is an archiving budget, and missions must address how they fit into that or will otherwise fund archives. HPS discussion of these and other points was pending completion of a more final draft.

3. There will be recommendations for the Roadmap team about cost containment. HPS will also address the DS decision rules. Dr. Karpen presented the draft cost containment statement, which was lengthy, pending an edit. She explained that HPS was asking the Roadmap team to evaluate the efficacy of the recent cost containment strategies, while also including the measures in the Roadmap and informing the community about the measures. The Subcommittee also wanted HPD to consider and enforce the DS decision rules, and to include a statement to that effect in the Roadmap.

Dr. Giles agreed, noting that this was in line with HPD's direction.

4. HPS is endorsing the review of NASA's cyber-infrastructure, as proposed by ITIC. However, the Subcommittee also noted that Dr. Smarr seemed surprised to learn that their IT problems related primarily to network access and simpler interfaces, not high-speed computing. The recommendation was not yet in its final form.

Dr. Giles advised writing the endorsement of the study in a way that helps point it toward the problems HPS members identified. She also suggested recommending individuals who might participate in the study, especially since HPS believes the study committee should be a wide-ranging group.

Adjourn

Drs. Hagan and Giles thanked the Subcommittee members for their hard work. Proposed topics for the next meeting included additional information on mission costs, the Roadmap, the status of the IT study, and implementation of DRIVE. That will also be the time for the annual ethics briefing. Dr. Hagan asked members to email her with any other suggestions.

A discussion of the next meeting date was inconclusive, though dates in the latter half of January and in February were to be pursued off-line. At that meeting, there might be three new members, though Dr. Newmark said that the Agency was going to extend the terms of the members who were to depart.

Dr. Hagan closed by noting that she and Drs. Giles, Newmark, and Deluca were to give an interim report on Roadmap activities that afternoon, and that the community would be able to access it live or via the archived press conference.

The meeting was adjourned at 11:48 a.m.

Appendix A
Attendees

Heliophysics Subcommittee members
Maura Hagan, Chair, National Center for Atmospheric Research
Mihir Desai, Southwest Research Institute
Jeffrey Hughes, Boston University
Judith Karpen, NASA Goddard Space Flight Center
Robert McPherron, University of California
Ennio Sanchez, SRI International
Leonard Strachan, Harvard Smithsonian Center for Astrophysics
Charles Swenson, Utah State University
Jeffrey Newmark, NASA HQ, Executive Secretary

NASA Attendees
Stephen Ballard, NASA
Max Bernstein, NASA
Joan Centrella, NASA HQ
Dave DeMineo, NASA GSFC
Victoria Elsbernd, NASA HQ
T. Jens Feeley, NASA HQ
Barbara Giles, Director HPD, NASA HQ
Lika Guhathakurta, NASA HQ
Hashima Hasan, NASA HQ
Jeffrey Hayes, NASA HQ
Larry Kaplan, NASA GSFC
David Klumpar, NASA HQ
William Knopf, NASA HQ
John Lee, NASA HQ
Tsengdar Lee, NASA HQ
Roy Maizel, NASA HQ
Jeff Newmark, NASA HQ
Marian Norris, NASA HQ
Arik Posner, NASA HQ
Jenny Rumburg, NASA HQ
James Spann, NASA HQ
Beth Weinstein, NASA HQ

Other Attendees
Art Charo, NRC
Dom Conte, Orbital Sciences
Ed Deluca, SAO
Elizabeth Sheley, Zantech IT
Shannon Valley, OCHA
Ana Wilson, Zantech IT

Appendix B
Subcommittee Membership

Maura Hagan (Chair)
National Center for Atmospheric Research
Boulder, CO

Jeffrey Hughes
Astronomy Department
Boston University

Judith Karpen
NASA Goddard Space Flight Center

Robert McPherron
Institute of Geophysics and Planetary Physics
University of California at Los Angeles

Ennio Sanchez
SRI International

Karel Schrijver
Principal Physicist
Solar and Astrophysics Laboratory

Leonard Strachan
Harvard-Smithsonian Center for Astrophysics

Charles Swenson
Center for Space Engineering
Utah State University

Jeffrey Newmark
Executive Secretary HPS
NASA Headquarters

Marion Norris
Management Support Specialist
Science Mission Directorate
NASA Headquarters

Appendix C
Presentations

1. Heliophysics Division Status; Barbara Giles
2. Heliophysics Division Flight Program Status; Victoria Elsbernd
3. Measurement Techniques for Solar and Space Physics; James Spann
4. Heliophysics Division Research Program; Arik Posner
5. Division Comments on Decadal Survey for Solar and Space Physics; Barbara Giles
6. Science Mission Directorate: Improving Mission Cost Performance; Roy Maizel
7. The Effects of Solar Variability on Earth's Climate: A Workshop Summary; Lika Guhathakurta and Karel Schrijver
8. 2012 Heliophysics Roadmap Report to Heliophysics Subcommittee; Ed Deluca
9. Information Technology Infrastructure Committee (ITIC) Briefing; Larry Smarr
10. Senior Review Discussion; Jeffrey Hayes
11. Launch Update; Jim Norman and Darren Bedell

Appendix D
Agenda

Heliophysics Subcommittee Meeting

October 10-12, 2012

Wednesday October 10; MIC-6 (Room 6H45)

8:30 Subcommittee Room Open

9:00 Welcome, Overview of agenda — M. Hagan, HPS Chair

9:15 Heliophysics Division Overview — B. Giles, NASA HQ

10:00 Flight Program Status — V. Elsbernd, NASA HQ

10:15 BREAK

10:30 Measurement Techniques Workshop — J. Spann, NASA MSFC

11:00 R&A Status — A. Posner, NASA HQ

12:00 LUNCH:

1:00 Heliophysics Division Comments on National Research Council Decadal Strategy for Solar and Space Physics Report — B. Giles, NASA HQ

3:00 BREAK

3:15 NASA-SMD Mission Cost History — V. Roeum, NASA HQ

4:00 NAS: The Effects of Solar Variability on Earth's Climate: A Workshop Report — L. Guhathakurta, NASA HQ; K. Schrijver, LMSAL

5:00 END OF DAY

Heliophysics Subcommittee Meeting

October 10-12, 2012

Thursday October 11: MIC-6 (Room 6H45)

8:00 Subcommittee Room Open

8:30 Heliophysics Roadmap for Science and Technology 2013 – 2033 Status — E. Deluca, Roadmap Chair

10:15 BREAK

10:30 Heliophysics Roadmap Discussion. — E. Deluca, Roadmap Chair

12:00 LUNCH

1:30 NAC IT Infrastructure — L. Smarr, NAC

2:30 Heliophysics Senior Review Guidelines — J. Hayes, NASA HQ

3:00 BREAK

3:15 NASA Launch Services Briefing — J. Norman, NASA HQ

4:15 Subcommittee work session(s) — Subcommittee

5:00 END OF DAY

Group Dinner

Heliophysics Subcommittee Meeting

October 10-12, 2012

Friday October 12: MIC-7 (Room 7H45)

8:30 Subcommittee Room Open

9:00 Subcommittee work session(s) Subcommittee

10:15 BREAK

10:30 Debrief with the Heliophysics Division Director B. Giles, NASA HQ

11:30 ADJOURN